What is claimed is:

(1) A plasma device comprising:

a container, the inside of which can be internally decompressed, and part of the inside being formed of a first dielectric plate made of material capable of transmitting microwaves with almost no loss,

a gas supply system for supplying essential source material gas so as to cause excitation of plasma inside the container,

an exhaust system for expelling source material gas that has been supplied into the container and decompressing the inside of the container,

an antenna, located facing an outer surface of the first dielectric plate and comprised of a slot plate and a waveguide dielectric, for radiating microwaves, and

an electrode for holding a object to be treated located inside the container, a surface of the object to be treated to be subject to plasma processing and a microwave radiating surface of the antenna being arranged in parallel substantially opposite to each other, and the plasma device carrying out plasma processing for the object to be treated, wherein,

a wall section of the container outside the first dielectric plate is of a material comprising matter having a conductivity of $3.7 \times 10^{7}\Omega^{-1}/m^{-1}$ or more, or the inside of the wall section is covered with this material, and

where thickness of the material is d, the specific conductivity of the material is σ, the magnetic permeability of vacuum is μ_0, and the angular frequency of microwaves radiated from the antenna is ω, the thickness d is larger than $(2/\mu_0\sigma\omega)^{1/2}$.

(2) The plasma device as disclosed in claim 1, wherein:

a first O ring is located between an inner surface of the first dielectric body and a wall section of the container; and

a thin film formed of a conductive material is provided on at least a surface of the first dielectric plate coming into contact with the first O ring, as means for preventing the first O ring from being directly exposed to microwaves radiated from the antenna.

(3) The plasma device as disclosed in claim 2, wherein said thin film is formed from a material having a conductivity of at least $3.7 \times 10^{7}\Omega^{-1}\bullet m^{-1}$, and has a thickness of at

least 10μm.

(4) The plasma device as disclosed in claim 1, wherein:

a first O ring having a vacuum sealing function is located between an inner surface of the first dielectric body and a wall section of the container; and

a thin film formed of a conductive material is coated on the surface of the first O ring, ~~as means~~ for preventing the first O ring from being directly exposed to microwaves radiated from the antenna.

(5) The plasma device as disclosed in claim 4, wherein said metallic thin film is formed from a material having a conductivity of at least $3.7 \times 10^{7} \Omega^{-1} \bullet m^{-1}$, and has a thickness of at least 10μm.

(6) The plasma device as disclosed in Claim 1, wherein a second dielectric plate having a gas inlet for substantially uniformly supplying desired gas is provided between the first dielectric plate and the electrode for holding the object to be processed.

(7) The plasma device as disclosed in claim 6, wherein:

a second O ring having a vacuum sealing function is located between an inner surface of the second dielectric body and a wall section of the container; and

a thin film formed of a conductive material is provided on at least a surface of the second dielectric plate coming into contact with the second O ring, as means for preventing the second O ring from being directly exposed to microwaves radiated from the antenna.

(8) The plasma device as disclosed in claim 6, wherein:

a second O ring having a vacuum sealing function is located between an inner surface of the second dielectric body and a wall section of the container; and

a thin film formed of a conductive material is coated on the surface of the second O ring, as means for preventing the second O ring from being directly exposed to microwaves radiated from the antenna.

(9) The plasma device as disclosed in claim 1, wherein the first dielectric plate is

formed of a material having a dielectric loss angle tanδ of less than 10^{-3}.

(10) The plasma device as disclosed in claim 6, wherein the second dielectric plate is formed of a material having a dielectric loss angle tanδ of less than 10^{-3}.

(11) The plasma device as disclosed in claim 1, wherein a space is formed between the antenna and the first dielectric plate.

(12) The plasma device as disclosed in claim 11, wherein a line for supplying heating medium communicates with the space formed between the antenna and the first dielectric plate.

(13) The plasma device as disclosed in claim 6, wherein the frequency of microwaves fed to the antenna is at least 5.0GHz, and a width of a space 1 between the first dielectric plate and the second dielectric plate is less than 0.7mm.

(14) The plasma device as disclosed in claim 6, provided with means for generating a pressure difference so that a pressure 1 of the space 1 between the first dielectric plate and the second dielectric plate is higher than a pressure 2 of a space 2, in which the electrode for holding the object to be treated is located, and which is surrounded by the second dielectric plate and a wall section of the container other than the second dielectric plate.

(15) The plasma device as disclosed in claim 6, wherein means for introducing heating medium is connected into the space 2 surrounded by the second dielectric plate and a wall section of the container other than the second dielectric plate.

(16) The plasma device of claim 14, the antenna being provided with a slot plate functioning as a microwave radiating surface, and slot sets comprising a holes penetrating the slot plate at a plurality of fixed location, wherein, at portions where the density of plasma generated in the space 2 is locally higher than other portions, the slots either have a smaller diameter than at other portions, are screened by a screen plate, or are not provided at all.

(17) The plasma device as disclosed in claim 1, provided with means 6 for cooling the antenna.

(18) The plasma device as disclosed in claim 17, wherein a passageway is formed in the antenna guide, and a line for supplying heating medium communicates with the passageway.

(19) The plasma device as disclosed in claim 1, provided with means 7 for cooling the first dielectric plate.

(20) The plasma device as disclosed in claim 1, provided with means 8 for preventing warping of the slot plate.

(21) The plasma device as disclosed in claim 20, wherein a space is provided between the antenna and the first dielectric plate, and a plate composed of a flexible member is interposed in the space as means for preventing warping of the slot plate.

(22) The plasma device as disclosed in claim 1, provided with means 9 for detecting the presence or absence of plasma generated in the space 2.

(23) The plasma device as disclosed in claim 1, provided with a mechanism for causing the temperature of a wall section inside the container and sections inside the container other than the object to be treated, to respectively rise to 150°C.

(24) The plasma device as disclosed in claim 1, wherein the exhaust system is provided with a mechanism for causing the temperature inside all units comprising the exhaust system, to respectively to rise to 150°C.

(25) The plasma device as disclosed in claim 1, wherein the electrode having the function of holding the object to be treated has a mechanism for heating the object to be treated.

(26) The plasma device as disclosed in claim 25, wherein a xenon lamp is used as the mechanism for heating the object to be treated.

(27) The plasma device as disclosed in claim 1, wherein a mechanism for collecting and recycling fluorocarbon type gas is provided downstream of the exhaust system.

(28) The plasma device as disclosed in ~~any one of~~ claims 1 ~~to 20~~, wherein a film comprising AlF_3 and MgF_2 is formed on an inner wall surface of the container.

(29) The plasma device as disclosed in claim 1, wherein the electrode having the function of holding the object to be treated is provided with a dc bias and/or an ac bias applying means.

(30) The plasma device as disclosed in claim 1, wherein said plasma device is a device for carrying out etching of a surface the object to be treated.

(31) The plasma device as disclosed in claim 1, wherein said plasma device is a device for causing direct oxidation of a surface of the object to be treated.

(32) The plasma device as disclosed in claim 1, wherein said plasma device is a device for causing direct nitridation of a surface of the object to be treated.

(33) The plasma device as disclosed in claim 1, wherein said plasma device is a device for causing a thin film to be deposited on the object to be treated.

(34) A plasma processing method using a plasma device comprising a container, the inside of which can be internally decompressed, and part of the inside being formed of a first dielectric plate made of material capable of passing microwaves with almost no loss, a gas supply system for supplying essential source material gas so as to cause excitation of plasma inside the container, an exhaust system for expelling source material gas that has been supplied inside the container and decompressing the inside of the container, an antenna, located facing an outer surface of the first dielectric plate and comprised of a slot plate and a waveguide dielectric, for radiating microwaves, and an

electrode for holding an object to be treated located inside the container, a surface of the object to be treated that is to be subject to plasma processing and a microwave radiating surface of the antenna being arranged in parallel substantially opposite to each other, and the plasma device carrying out plasma processing for the object to be treated, the power density of microwaves to be input being 1.2 W/cm^2 or more.

(35) The plasma processing method as disclosed in claim 34, wherein a ~~pressure~~ 1 ~~of the space~~ 1 between the first dielectric plate and the second dielectric plate is made higher than a pressure 2 of a space 2, in which the electrode for holding the object to be treated is located, and which is surrounded by the second dielectric plate and a wall section of the container other than the second dielectric plate.

(36) A plasma device comprising:

an electrode I inside a vacuum container, with a substrate to be subjected to processing using plasma being mounted so as to be connected to this electrode 1, and

magnetic field applying means I and II provided outside the vacuum container, for applying a magnetic field to the inside of the plasma, wherein

at least some of a gas that has been introduced into the vacuum container is expelled through a space between the magnetic field applying means I and II.

(37) The plasma device as disclosed in claim 36, wherein the magnetic field applying means I and II are annular magnets comprising a plurality of permanent magnets.

(38) The plasma device as disclosed in claim 36 or claim 37, wherein the magnetic field is substantially horizontal with respect to a surface of the substrate that is to be subject to plasma processing, and is substantially unidirectional.

(39) A plasma device, provided with two parallel plate type electrodes I and II inside a vacuum container, and a substrate to be subjected to processing using plasma being mounted so as to be connected to either the electrode I or the electrode II, and means for applying a magnetic field to the inside of the plasma, the electrode II comprising a central section, and an outer section connected to a high frequency power

source that can be controlled independently of a high frequency power source connected to the electrode I.

(40) The plasma device as disclosed in claim 39, wherein a central portion of the electrode II is electrically grounded.

(41) The plasma device as disclosed in claim 39 or claim 40, wherein the magnetic field is substantially horizontal with respect to a surface of the substrate that is to be subject to plasma processing, and is substantially unidirectional.

(42) The plasma device as disclosed in claim 39 or claim 40, wherein the magnetic field is applied using an annular magnet comprising a plurality of permanent magnets provided outside the vacuum container.

(43) The plasma device as disclosed in claim 39, claim 40 or claim 41, wherein the magnetic field is applied using annular magnets I and II comprising a plurality of permanent magnets provided outside the vacuum container, and at least some of the gas that has been introduced into the vacuum container is expelled by passing between the magnets I and II.

(44) The plasma device as disclosed in ~~any one of~~ claims 36 - ~~43~~, wherein at least some of the gas that has been introduced into the vacuum container is expelled from three or more exhaust outlets having substantially the same cross sectional area and located at the edge of the substrate at substantially axially symmetrical positions with respect to an axis vertical to the substrate surface and passing through the center of the substrate.

(45) A plasma device having an electrode provided in a vacuum container, and a substrate to be subjected to plasma processing is mounted so as to come into contact with the electrode, wherein at least some of a gas that has been introduced into the vacuum container is expelled from three or more exhaust outlets having substantially the same cross sectional area and located at the edge of the substrate at substantially axially symmetrical positions with respect to an axis vertical to the substrate surface and

passing through the center of the substrate.

(46) The plasma device as disclosed in claim 44 or claim 45, wherein a vacuum pump is connected to each exhaust outlet.

(47) A plasma device with an exhaust space formed in direct contact with an intake port of a vacuum port provided beside ~~of~~ a film formation space above a substrate.

(48) The plasma device as disclosed in claim 47, wherein the width of the exhaust space is at least double the height of the film formation space.

(49) The plasma device as disclosed in Claim 47, wherein two or more vacuum pumps having substantially the same intake port area are arranged at symmetrical positions with respect to a substantially central point of the substrate.

(50) The plasma device as disclosed in claim 47, wherein the film formation space is located in an upper, lower or side part of the intake port of the vacuum pump.

(51) A plasma device comprising:

a container, the inside of which can be internally decompressed, and part of the inside being formed of a first dielectric plate made of material capable of passing microwaves with almost no loss,

a gas supply system for supplying essential source material gas so as to cause excitation of plasma inside the container,

an exhaust system for expelling source material gas that has been supplied inside the container and decompressing the inside of the container,

an antenna, located facing an outer surface of the first dielectric plate and comprised of a slot plate and a waveguide dielectric, for radiating microwaves, and

an electrode for holding an object to be treated located inside the container, a surface of the object to be treated that is to be subject to plasma processing and a microwave radiating surface of the antenna being arranged in parallel substantially opposite to each other, and the plasma device carrying out plasma processing for the object to be treated, wherein,

an exhaust space formed directly communicating with an inlet of a vacuum pump is provided to the side of a film forming space above the substrate.

(52) The plasma device as disclosed in claim 51, wherein the width of the exhaust space is at least double the height of the film formation space.

(53) The plasma device as disclosed in claim 51, wherein:

a wall section of the container outside the first dielectric plate is of a material comprising material having a conductivity of 3.7 x $10^7\Omega^{-1}/m^{-1}$ or more, or the inside of the wall section is covered with this material, and

where when thickness of the material is d, the specific conductivity of the material is σ, the magnetic permeability of vacuum is μ_0, and the angular frequency of microwaves radiated from the antenna is ω, the thickness d is larger than $(2/\mu_0\sigma\omega)^{1/2}$.

(54) The plasma device as disclosed in claim 51, wherein:

a first O ring is located between an inner surface of the first dielectric body and a wall section of the container; and

a thin film formed of a conductive material is provided on at least a surface of the first dielectric plate coming into contact with the first O ring, as means for preventing the first O ring from being directly exposed to microwaves radiated from the antenna.

(55) The plasma device as disclosed in claim 54, wherein the thin film is formed of a material having a conductivity of 3.7 x $10^7\Omega^{-1}/m^{-1}$ or more, and has a thickness of at least 10μm.

(56) The plasma device as disclosed in claim 55, wherein:

a first O ring having a vacuum sealing function is located between an inner surface of the first dielectric body and a wall section of the container; and

a thin film formed of a conductive material is coated on the surface of the first O ring, as means for preventing the first O ring from being directly exposed to microwaves radiated from the antenna.

(57) The plasma device as disclosed in claim 56, wherein said metallic thin film is formed from a material having a conductivity of at least $3.7 \times 10^{7}\Omega^{-1}\bullet m^{-1}$, and has a thickness of at least 10μm.

(58) The plasma device as disclosed in Claim 51, wherein a second dielectric plate having a gas inlet for substantially uniformly supplying desired gas is provided between the first dielectric plate and the electrode for holding the object to be processed.

(59) The plasma device as disclosed in claim 58, wherein:

a second O ring having a vacuum sealing function is located between an inner surface of the second dielectric body and a wall section of the container; and

a thin film formed of a conductive material is provided on at least a surface of the second dielectric plate coming into contact with the second O ring, as means for preventing the second O ring from being directly exposed to microwaves radiated from the antenna.

(60) The plasma device as disclosed in claim 58, wherein:

a second O ring having a vacuum sealing function is located between an inner surface of the second dielectric body and a wall section of the container; and

a thin film formed of a conductive material is coated on the surface of the second O ring, as means for preventing the second O ring from being directly exposed to microwaves radiated from the antenna.

(61) The plasma device as disclosed in claim 51, wherein the first dielectric plate is formed of a material having a dielectric loss angle tanδ of less than 10^{-3}.

(62) The plasma device as disclosed in claim 58, wherein the second dielectric plate is formed of a material having a dielectric loss angle tanδ of less than 10^{-3}.

(63) The plasma device as disclosed in claim 51, wherein a space is formed between the antenna and the first dielectric plate.

(64) The plasma device as disclosed in claim 63, wherein a line for supplying heating

medium communicates with the space formed between the antenna and the first dielectric plate.

(65) The plasma device as disclosed in claim 58, wherein the frequency of microwaves fed to the antenna is at least 5.0GHz, and a width of a space 1 between the first dielectric plate and the second dielectric plate is less than 0.7mm.

(66) The plasma device as disclosed in claim 58, provided with means for generating a difference pressure so that a ~~pressure 1 of the~~ space ~~1~~ between the first dielectric plate and the second dielectric plate is higher than a ~~pressure~~ 2 of a ~~space~~ 2, in which the electrode for holding the object to be treated is located, and which is surrounded by the second dielectric plate and a wall section of the container other than the second dielectric plate.

(67) The plasma device as disclosed in claim 58, wherein means for introducing heating medium is connected into the space 2 surrounded by the second dielectric plate and a wall section of the container other than the second dielectric plate.

(68) The plasma device of claim 51, the antenna being provided with a slot plate functioning as a microwave radiating surface, and slot sets comprising hole sections (hereinafter called slots) penetrating the slot plate at a plurality of fixed locations, wherein, at portions where the density of plasma generated in the space 2 is locally higher than other portions, the hole slots either have a smaller diameter than at other portions, are screened by a screen plate, or are not provided at all.

(69) The plasma device as disclosed in claim 51, provided with means for cooling the antenna.

(70) The plasma device as disclosed in claim 69, wherein a passageway is formed in the antenna guide, and a line for supplying heating medium is connected to the passageway.

(71) The plasma device as disclosed in claim 51, provided with means 7 for cooling

the first dielectric plate.

(72) The plasma device as disclosed in claim 51, provided with means for preventing bending of the slot plate.

(73) The plasma device as disclosed in claim 72 wherein a space is provided between the antenna and the first dielectric plate, and a plate composed of a flexible member is interposed in the space as means for preventing bending of the slot plate.